

The Power of the pitt bacteremia score in bloodstream infections in older adults

Bloodstream infections in older adults

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Abstract

Aim: High morbidity and mortality rates, particularly among older adults, are associated with bloodstream infections (BSIs). This study evaluates clinical characteristics, microbiological profile, and predictive factors of 30-day mortality in BSI patients.

Materials and Methods: A retrospective study was conducted on 1,147 BSI patients from a tertiary hospital. Patients were classified based on pathogen type—Gram-positive bacteria (GPB), Gram-negative bacteria (GNB), and others—and mortality outcomes were assessed.

Results: A 64.9% rate of BSIs was attributed to GNB in the study. GNB infections had a significantly higher 30-day mortality rate (70.4%, n=380) than GPB (28.7%, n=155), resulting in an overall mortality rate of 47.1% (n=540). Increased intensive care unit (ICU) lengths of stay, higher Pitt Bacteremia Scores (PBS), and more frequent use of mechanical ventilation and vasopressors were observed in non-survivors. PBS was identified as the strongest predictor of mortality, with each one-unit increase in PBS being associated with a 61% higher risk of death (Odds Ratio [OR] = 1.61, 95% Confidence Interval [CI]: 1.53–1.69, $p < 0.001$).

Discussion: This research shows the substantial burden of BSIs in older adults, thus emphasizing the need for early risk assessment through PBS and implementing targeted antimicrobial therapies for better outcomes.

Keywords

Bloodstream Infections, Gram-Negative Bacteria, Gram-Positive Bacteria, Mortality, Pitt Bacteremia Score

DOI: 10.4328/ACAM.22781 Received: 2025-06-19 Accepted: 2025-07-30 Published Online: 2025-07-31 Printed: 2025-08-01 Ann Clin Anal Med 2025;16(8):592-597
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This study was approved by the Ethics Committee of Basaksehir Cam and Sakura City Hospital (Date: 2024.03.13, No:181)

Introduction

Aging, an unavoidable physiological process, is accompanied by immunosenescence [1]. The aging process affects both the cell-mediated and humoral immune responses, and many innate immune functions are also impaired. Within this context, a rise in the percentage of deaths among older adults attributable to certain infectious diseases is anticipated [2]. Studies show age is an independent risk factor for death caused by infection [2-4]. The global population of people aged 60 years and over is expected to be 22% by 2030 [5], making infections and deaths within this age group increasingly significant for the entire world.

The high morbidity and mortality rates associated with bloodstream infections (BSIs) worldwide place a considerable burden on healthcare systems [6]. BSI by pathogenic microorganisms results in these infections, characterized by systemic inflammatory responses; severe cases may cause septic shock and multi-organ failure. Patient demographics, healthcare practices, and developing antimicrobial resistance significantly affect the complex epidemiology of BSIs [6]. Their impact on healthcare is substantial, especially within hospitals and among patients with compromised immunity. Gram-positive bacteria (GPB), gram-negative bacteria (GNB), and fungal agents are among the various pathogens that may lead to BSIs [7]. Recent decades have seen an increase in BSIs, driven by factors including an aging population, the growing use of immunosuppressive treatments, and the increased use of invasive medical devices (like central venous catheters and ventilators) [7].

BSIs result in higher healthcare spending, longer hospitalizations, and increased intensive care unit (ICU) demand [8]. Research indicates that patients with BSIs, especially those caused by multidrug-resistant (MDR) pathogens, experience substantially longer hospital stays and increased ICU admission rates than those with infections from susceptible strains [8,9]. Analysis of deceased patients at two hospitals showed a 15.1% (280 patients) rate of BSI in the two weeks before death, emphasizing BSIs' considerable impact on mortality [10]. Disease severity and clinical outcome prediction in patients with BSIs frequently involve the use of the Pitt bacteremia score (PBS) [10].

Patient factors, pathogen traits, and healthcare factors all contribute to the risk of death in BSI patients [11]. Depending on the pathogen, resistance, and comorbidities, 30-day mortality rates have been reported between 20% and 50% in recent studies [9,12,13]. Al-Hasan et al. found that in patients with GNB BSI, underlying conditions, non-urinary BSI sources, central venous catheter infections, and high PBS independently predicted 28-day mortality [14]. To understand the effect of BSIs on patients and healthcare, this study aimed to examine clinical characteristics, microbiological distribution, and predictors of 30-day mortality in patients with BSIs. Identifying key mortality risk factors allows us to optimize treatment and develop targeted interventions, thus contributing to improved patient prognosis.

Materials and Methods

This study retrospectively analyzed data from BSI patients treated at a tertiary care hospital from January 2020–January

2024.

Study population

This study's participants comprised 1,141 patients with confirmed BSIs. The inclusion criteria for the study were: (1) blood culture-confirmed bacteremia, (2) age 65 or older, and (3) complete clinical and laboratory data. The study excluded patients whose BSI stemmed from fungi or viruses, those lacking complete data, and those without consent (patient or relative). Based on the causative pathogen, patients were divided into three groups: GPB (390 patients), GNB (751 patients), and other bacteria (16 patients). Survival outcomes were determined by a 30-day mortality comparison of 601 survivors and 540 non-survivors.

Data collection and variables

Demographic, clinical, and microbiological data were obtained from the hospital information management system and patient files. Data collected included demographics (age, sex) and clinical variables (ICU admission, mechanical ventilation, vasopressors, mental status, hospital/ICU length of stay). Diabetes, cardiovascular diseases, malignancies, chronic pulmonary diseases, and neurological conditions (e.g., cerebrovascular accidents [CVA], epilepsy) were recorded. Microbiological data, including pathogen identification and antibiotic susceptibility, enabled infection classification. Bacteremia sources were categorized into primary, pneumonia-related, intraabdominal, hepatobiliary, urinary, and soft tissue/bone infections. The use of antibiotics, such as carbapenems, cephalosporins, and penicillins, was documented, both as monotherapy and combination therapy. Each patient had their PBS [9], a severity indicator, calculated. Thirty-day mortality, defined as death within 30 days of a positive blood culture, was the primary outcome. From patient blood cultures, microbiological analysis identified GPB (n=390) and GNB (n=751) microorganisms. Blood cultures underwent automated processing (e.g., BD BACTEC™, bioMérieux VITEK®), with bacterial identification via standard biochemical tests and Matrix-Assisted Laser Desorption Ionization-Time of Flight Mass Spectrometry (MALDI-TOF MS). The Clinical and Laboratory Standards Institute (CLSI) or the European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines direct the interpretation of antibiotic susceptibility tests.

Statistical analysis

R version 4.4.2, along with several packages, performed the statistical analysis, managed data, created visualizations, and generated reports. All variables underwent descriptive statistical analysis. The Shapiro-Wilk test determined whether the numerical data were normally distributed. Means and standard deviations (SD) described the parametric data. Medians, minimum, and maximum summarize the non-parametric data. Number and percentage (%) frequencies showed the categorical data.

T-tests analyzed normally distributed numerical data for two independent groups, while ANOVA handled comparisons of three or more. The Wilcoxon rank test was used for two groups and the Kruskal-Wallis test for multiple groups when data were non-normally distributed. Categorical data analysis employed Chi-square tests (sufficient cell counts >5) or Fisher's exact test (small samples). The independent variables were checked

for multicollinearity. To identify independent mortality risk factors, a multivariate binary logistic regression model included significant variables from univariate analysis. Results are shown as 95% confidence intervals (CIs) and odds ratios (OR). A P value below 0.05 was considered statistically significant.

Ethical Approval

This study was approved by the Ethics Committee of Basaksehir Cam and Sakura City Hospital (Date: 2024.03.13, No:181).

Results

Characteristics of participants

The study included 1,141 patients, mean age of 76.2 ± 8.0 years; 47.7% (n=544) were female. Table 1 shows participant clinical, microbiological data, and outcomes related to BSI. The most frequently isolated pathogens were Klebsiella pneumoniae (n=211), Staphylococcus aureus (n=194), and Escherichia coli (n=182). Table 2 lists the most frequently isolated pathogens in blood cultures. These findings highlight the distribution of clinically significant pathogens, particularly in nosocomial infections and antimicrobial resistance development. GNB (64.9%, n=751) was seen more than GPB (33.7%, n=390). Bacteremia most commonly stemmed from primary infections (48.6%, n=558), followed by pneumonia (27.8%, n=317) and urinary tract infections (9.2%, n=105).

Median hospital stays and ICU stays were 28 days (0–249), and 13 days (0–249), respectively. ICU admission occurred in 68.0% (n=780) of patients. PBS scores ranged from 0 to 14, with a median of 5 of 540 patients, 47.1% had the 30-day mortality.

Comparison between gram-positive and gram-negative bacteremia

A significant difference was observed between patients with GNB and GPB BSIs, with the former group showing significantly longer ICU (p=0.002) and hospital stays (p<0.001) and higher PBS levels (p=0.009). Pneumonia, hepatobiliary infections, and urinary tract infections occurred significantly more often with GNB (p<0.001). Mechanical ventilation, vasopressor support, and central venous catheters were significantly more needed in cases of GNB infections (p<0.001, p=0.030, and p=0.023, respectively). Patients with GNB had a substantially greater 30-day mortality rate than those with GPB (28.7% vs. 70.4%, p<0.001).

Comparison between survivors and non-survivors

The 30-day mortality rate was 47.1% (n=540). Non-survivors were significantly older (75 vs. 77 years old, p<0.001), had more GNB BSI (p<0.001), and were more likely to have ICU admission (p<0.001). Significantly increased ICU lengths of stay (6 vs. 21 days, p<0.001), PBS scores (2 vs. 10, p<0.001), and mechanical ventilation needs (21% vs 78.9%, p<0.001) were observed in

Table 1. Clinical and microbiological characteristics of patients with bloodstream infections and outcomes

Variable	Total n (%), n=1141	Variable	Total n (%), n=1141
Dementia	126 (11.0)	Bacteremia source	
Diabetes mellitus	459 (40.0)	Primary	558 (48.6)
Lung disease	255 (22.2)	Pneumonia	317 (27.8)
Neurological diseases		Urinary	105 (9.2)
CVA	267 (23.3)	Complicated soft tissue/bone	59 (5.2)
Epilepsy	19 (1.7)	Intraabdominal	53 (4.8)
Others	76 (6.6)	Hepatobiliary	49 (4.4)
Renal diseases		Central venous catheter	
Acute	142 (12.4)	Femoral	279 (24.3)
Chronic	101 (8.8)	Jugular	262 (22.8)
CRRT	78 (6.8)	Subclavicular	106 (9.2)
Cardiac diseases		Urinary catheter	
HT	492 (42.9)	Probe	803 (70.0)
IHD	139 (12.1)	Nephrostomy	12 (1.1)
CHF	100 (8.7)	Presence of NG/PEG/PEJ	421 (36.7)
Malignancy		Mechanical ventilation	544 (47.4)
Solid organ	235 (20.5)	Need for intravenous vasopressors	220 (19.2)
Hematological	30 (2.6)	Fever value (°C) *	36.6 ± 0.6
Prior immunosuppressive drug use		Systolic blood pressure <90 mmHg	89 (7.8)
Chemotherapy	86 (7.5)		
Steroids	25 (2.2)		
Biological agents	7 (0.6)		
Others	49 (4.3)		
COVID-19		Pitt bacteremia score*	5 (0-14)
Passed	82 (7.1)	Cardiac arrest	413 (36.0)
Current	74 (6.5)	30-day mortality	540 (47.1)

Notes: *Numeric variables were presented as median (minimum–maximum) or mean ± SD
Abbreviations: CHF: Chronic Heart Failure, COVID-19: Coronavirus Disease 2019, CRRT: Continuous Renal Replacement Therapy, CVA: Cerebral Vascular Accident, F: Female, ICU: Intensive Care Unit, HT: Hypertension, IHD: Ischaemic Heart Disease M: Male, mm: millimeter, NG: Nasogastric, PEG: Percutaneous Endoscopic Gastrostomy, PEJ: Percutaneous Endoscopic Jejunostomy

non-survivors. Non-survivors showed significantly higher rates of comorbidities, including lung disease (p=0.008), neurological conditions (p=0.014), and acute renal failure (p<0.001). Patients with pneumonia-related bacteremia had the greatest mortality (p<0.001). Mortality was significantly higher with a combination of antibiotic therapy (p<0.001).

Predictors of 30-day mortality

As shown in Table 3, multivariate logistic regression analysis revealed PBS to be the strongest predictor of 30-day mortality. The 30-day mortality rate increases by 61% with a one-unit increase in PBS (OR=1.61, 95% CI: 1.53-1.69, p<0.001). An association was found between GNB infections and an increased risk of 30-day mortality (OR=1.44, 95% CI: 1.01-2.06, p=0.046). Surprisingly, steroids have a protective effect against mortality (OR=0.34, 95% CI: 0.14-0.85, p=0.020).

Discussion

The high morbidity and mortality associated with BSIs make them a significant concern in healthcare. Key insights into

Table 2. The most frequently isolated pathogens in blood cultures

Rank		N
1	Klebsiella pneumoniae	211
2	Staphylococcus aureus	194
3	Escherichia coli	182
4	Acinetobacter baumannii	125
5	Staphylococcus epidermidis	68
6	Pseudomonas aeruginosa	64
7	Enterococcus faecalis	61
8	Enterococcus faecium	29
9	Burkholderia cepacia	20
10	Proteus mirabilis	18
11	Stenotrophomonas maltophilia	18
12	Enterobacter cloacae	14
13	Serratia marcescens	13
14	Staphylococcus hominis	9
15	Acinetobacter nosocomialis	8
16	Citrobacter freundii	7
17	Klebsiella aerogenes	7
18	Morganella morganii	7
19	Streptococcus pneumoniae	7
20	Bacteroides fragilis	6

Table 3. Predictors of 30-day mortality of participants

	OR (95% CI)	p
Age	1.01 (0.99-1.04)	0.245
Sex: male	1.15 (0.82-1.163)	0.417
Microorganism category (GPB: GNB)	1.44 (1.01-2.06)	0.046
Pitt bacteremia score	1.61 (1.53-1.69)	<0.001
Immunosuppressive drug use		<0.001
Steroids	0.34 (0.14-0.85)	0.020
Chemotherapy	0.62 (0.17-2.27)	0.465
Biological agents	1.48 (0.52-4.24)	0.465
Others	1.92 (0.20-18.15)	0.571

Abbreviations: CI, confidence interval; OR, odds ratio

the clinical features, microbial spread, and 30-day mortality prediction in older BSI patients emerged from our study. This study showed that higher PBS levels predicted 30-day death rates among older adults. In addition, a relationship existed between GNB infections and 30-day mortality. The results support prior studies, emphasizing the significant impact of BSIs, especially among older adults, critically ill individuals, and immunocompromised patients [6, 7].

Mortality was observed in almost half of the participants in the current study. Mortality rates in our cohort demonstrate the seriousness of BSIs. Previous studies [6, 10, 15-19] also reported high mortality rates associated with nosocomial BSIs. A retrospective propensity-matched cohort study, for example, revealed a considerable mortality burden linked to nosocomial BSIs, thus emphasizing the importance of effective preventive and management measures [20]. Our study’s death rate mirrored that of Gutiérrez-Gutiérrez and Tuncer [18,19], while others reported lower mortality among BSI patients [3,20,21]. Differences in mortality rates across studies might be due to variations in participant number, age, and the types of microorganisms involved.

Our study prominently revealed GNB as the leading causative pathogen, responsible for 64.9% of the cases. This aligns with prior epidemiological research showing a trend towards GNB predominance in nosocomial infections [15]. The most frequently occurring pathogens in this group were Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa. Limited treatment and increased mortality associated with MDR GNB are cause for alarm due to their increasing prevalence [8,13]. The worldwide surge in antimicrobial resistance is alarming; projections predict millions of annual deaths from drug-resistant infections by 2050 without intervention [21]. According to a study, antimicrobial resistance may cause over 39 million deaths by 2050, with older people disproportionately affected [21]. These points highlight the importance of early detection and timely antibiotic treatment for infections in older patients.

Existing research supports the identification of advanced age as a major risk factor for infection-related mortality [9,10,11,16]. The vulnerability of older patients to negative health consequences stems from their decreased physiological reserves and co-existing conditions [1]. Age is a universal risk factor for mortality in BSIs, as identified by a study emphasizing its significance in patient assessment [16]. The risk of death is substantially greater for older BSI patients with co-existing conditions [9,11]. Univariate analysis linked advanced age to mortality, but multivariate analysis, adjusting for age, sex, microorganism, and immunosuppressant use, identified high PBS as the strongest mortality predictor within 30 days in the present study.

Our study revealed that higher PBS scores strongly predicted mortality, indicating a correlation with poorer patient outcomes. Our findings agree with prior research [19] indicating the PBS is a useful tool for risk stratification and early identification of high-risk patients such as older adults. To improve early risk assessment in older adults with BSI, the PBS, due to its prognostic value, should be integrated into standard clinical practice. A study on older adults with MRSA bacteremia

showed a significant link between a PBS score of 3 or higher and 30-day mortality [2]. High PBS was a significant mortality predictor across GPB, GNB, and fungal BSIs in numerous studies [2,19,22]. Given these results, we propose that PBS is a valuable parameter for predicting BSI mortality risk in older adults.

Our study unexpectedly revealed a link between steroid use and reduced 30-day mortality among patients with BSI. This discovery supports earlier research indicating corticosteroids could lessen excessive inflammation during sepsis, possibly leading to better results [23]. Low-dose corticosteroids have been shown to lessen vasopressor dependence and improve hemodynamic stability among critically ill patients in studies [24]. Conversely, other research points to a potential link between long-term steroid use and increased secondary infections and mortality [25]. Further research is required to elucidate the effect of corticosteroids on BSI treatment.

This study has several strengths, including a large sample size (1,141 patients) and a specific focus on BSI in older adults, a vulnerable yet understudied population. The findings underscore the PBS as a strong predictor of 30-day mortality, reinforcing its clinical utility. Detailed microbiological and clinical analyses provide valuable insights into pathogen distribution and patient outcomes. The use of rigorous statistical methods, including multivariate logistic regression, enhances the study's reliability. Our study yields valuable insights into BSI risk factors and outcomes; however, it is not without limitations. Selection bias is a potential consequence of the retrospective design, limiting the generalizability of findings to diverse healthcare settings. The study's single-center design may limit the generalizability of its findings to other settings. Furthermore, the absence of geriatric syndrome data in this study precluded assessing how frailty, malnutrition, and sarcopenia impact mortality in BSI cases. To validate these findings and explore other factors affecting BSI outcomes, future multicenter prospective studies are needed.

Limitation

This study has several limitations that warrant consideration. First, its retrospective and single-center design may introduce selection bias and limit the generalizability of the findings to other healthcare settings or populations. Second, although the Pitt Bacteremia Score (PBS) was identified as a strong predictor of mortality, other potentially relevant prognostic tools, such as the Charlson Comorbidity Index or SOFA score, were not assessed for comparison. Future multicenter prospective studies incorporating functional assessments and broader pathogen profiles are needed to validate and extend these findings.

Conclusion

Findings highlight the substantial burden of BSIs and pinpoint key indicators for 30-day mortality. This study demonstrated the Pitt bacteremia score's ability to predict mortality in older patients. High mortality rates associated with BSIs continue to pose a serious threat to patient health. Demonstrating the effectiveness of short, rapid, and useful parameters, such as PBS, in predicting mortality is vital for developing improved prevention and management strategies in clinical settings. Combating BSIs requires strong infection control, proper antimicrobial treatment, and close monitoring of drug resistance.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Funding: None

Conflict of Interest

The authors declare that there is no conflict of interest.

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How to cite this article:
Onur Ozalp, Ebru Muderrisoğlu, Fatih Tune, Fatma Yildiz, Meryem Sahin Ozdemir, Alper Gunduz. The Power of the pitt bacteremia score in bloodstream infections in older adults. *Ann Clin Anal Med* 2025;16(8):592-597

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